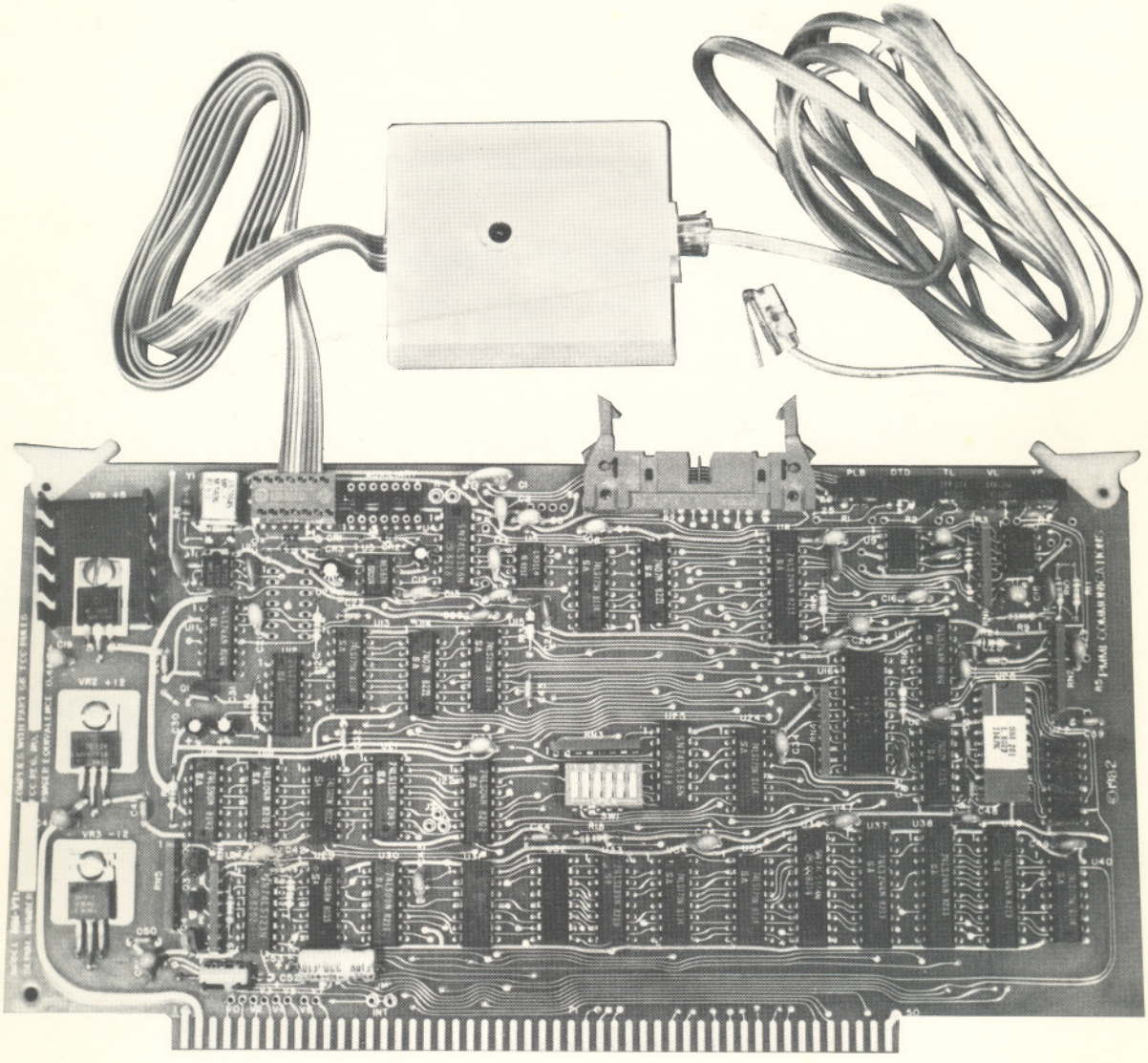
COMMUNICATIONS



MM-VT1

Touch-Tone Transmitter/Receiver with Speech Synthesizer

OWNER'S MANUAL

HOW TO USE THIS MANUAL

Thank you for purchasing another quality PMMI product. We hope this manual will be of assistance to you in getting your MM-VT1 up and running. For a quick reference guide to answer your questions please see the list below.

Refer to section:
1.0 When to call the phone company
5.0 Getting the MM-VT1 up and running
5.4 Setting the port address switches
8.0 Making adjustments to the pots
11.0 How to trouble-shoot problems
12.0 Software examples

This manual is intended to make using your MM-VT1 a pleasurable experience. Topics covered range from information on plugging in the card and running for the first-time user, to software examples and trouble-shooting techniques for the experienced user.

If you still have questions after referring to this manual, call our highly trained and competent service department. We will be more than happy to answer any questions you may have.

FCC PART 15 STATEMENT

WARNING: *This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.*

For additional discussion of Part 15 of the FCC Rules, see Section 4.2.

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WARNING:

DO NOT INSTALL OR REMOVE BOARD WITH POWER ON!

1.0 INSTRUCTIONS TO THE USER

The MM-VT1 and protective coupler have been approved by the Federal Communications Commission for direct connection to the public switched telephone network through standard plugs and jacks prescribed by Part 68 of the FCC rules and regulations. No connection can be made to party line or coin-operated telephones. Before connecting the MM-VT1 to the phone line you must do the following:

1. Call your local telephone office and inform them that you wish to connect an FCC-registered device to your telephone line. Provide them with the FCC registration and ringer equivalence numbers which are on the label on the outside of the protective coupler.

2. Inform the telephone company that the jack required for your equipment is an RJ11C for a single line unit.

3. When the telephone company has installed the jack, insert the PC board into your computer, attaching the flat cable connector on the coupler to the PC board. Then connect one end of the phone cord to the coupler and the other to the RJ11C jack.

Should it ever appear that the board is malfunctioning, it must immediately be disconnected until the source of the problem can be determined and either the board or the phone line repaired. If the board needs repair it must be returned to PMMI.

Should the telephone company determine that the MM-VT1 is causing harm to the telephone network, they may temporarily discontinue your service. In such case, they are required by the FCC to promptly notify you and give you the opportunity to correct the problem. You have the right to bring a complaint to the FCC in accordance with procedures set forth in Subpart E of Part 68 of the FCC rules and regulations.

Should the telephone company find it necessary to make changes in its communications facilities, equipment, operations, or procedures that could reasonably make your MM-VT1 incompatible with the telephone network, they must notify you in writing, sufficiently in advance of implementing the change(s) so that you have the opportunity to maintain uninterrupted service.

If your MM-VT1 is permanently disconnected from the telephone network, the telephone company must be notified.

2.0 INSTRUCTIONS FOR RETURN OF MM-VT1 FOR REPAIR

Should it ever be determined, either through use of the diagnostic software provided by PMMI or through some other means, that your MM-VT1 and/or protective coupler has malfunctioned, both the PC board and the coupler **must** be returned to PMMI for repair, either directly or through the distributor from which the unit was purchased.

Under the FCC direct connect program, no user is authorized to repair this equipment. This applies whether the equipment is in or out of warranty. If any unauthorized repair is attempted, the FCC registration of the equipment immediately becomes null and void. In addition, unauthorized repair immediately nullifies the warranty.

It is the responsibility of the user to insure that unauthorized repairs are not attempted. If the user believes the equipment needs repair, he must contact PMMI for instructions for return of the equipment. If the unit is in warranty, the repair will be made at no cost to the user. If the equipment is out of warranty, repair will be accomplished for a fixed fee.

2.1 ONE YEAR LIMITED WARRANTY

Potomac Micro-Magic, Inc. warrants (to the original purchaser only) the material and workmanship of the MM-VT1 and protective coupler for one year after delivery to the original purchaser.

Potomac Micro-Magic, Inc. or its authorized service centers will repair or replace and return to the original purchaser, without charge, the equipment which shall fail due to defective material or workmanship within said prescribed period, provided and on condition that:

1. The warranty card has been properly completed and returned to Potomac Micro-Magic, Inc. and
2. The MM-VT1 and protective coupler are promptly delivered, with all handling and freight charges prepaid, to a PMMI authorized service center. Call **(703) 379-9660**, or write to the following address:

PMMI COMMUNICATIONS
5201 Leesburg Pike, Suite 604
Falls Church, VA 22041

3. The seal on the data coupler has not been broken.

This supercedes any written or implied warranty.
Effective Date: June 1, 1982.

WARNING: The MM-VT1 *alone* must not be relied upon for total data integrity, particularly when used in critical applications such as life support systems and industrial control applications. The user must incorporate other recognized means of detecting data failure if absolute data integrity is required.

3.0 INTRODUCTION

The MM-VT1 is an IEEE 696/S-100 compatible telecommunications device which allows a remote user to interface effectively with a micro computer over the telephone line *without the need of any kind of terminal device.* All that is required is a Touch-Tone telephone so that the user can use the pad to key in data or instructions. The MM-VT1 can prompt the user and acknowledge receipt of data via the speech synthesizer.

The PMMI MM-VT1, as a direct connect device, interfaces directly to the phone line. It has been approved by the FCC under Part 68 of the FCC rules. The MM-VT1 has also been verified under Part 15 of the FCC rules as a Class A computing device. See Section 5.0, Installation Instructions, for recommendations on correctly installing your board.

The MM-VT1 can bring new and powerful capabilities to your computer system. Now you can call your computer and receive inventory, alarm or status information from any Touch-Tone phone. The MM-VT1 is suited especially well for remote computer locations where automatic calling and reporting capability is a must. Remote control of equipment is easily implemented with the parallel port. The voice can give you positive feedback on system or equipment performance and keep you informed on the progress of commands you've previously entered on the Touch-Tone pad.

The speech synthesizer used is a phoneme-type with unlimited vocabulary. With PMMI's software, you can easily create your own vocabulary to suit your own special needs. Inflection of speech is adjusted through software to one of four levels for each phoneme. The starting inflection is continuously adjustable from a growl to a 'Mickey Mouse' sound using the adjustment marked "VP" on the board.

The Touch-Tone encoder and decoder generate and receive all 16 tones including A, B, C and D, which are not on the normal Touch-Tone phone, but are part of the standard DTMF (dual tone multifrequency) frequencies. Data reliability and integrity are extremely high using the DTMF technique. Typically, the receiver will either decode the tone or miss completely. We have not been able, with thousands of tests, to make it decode an incorrect tone. The board also has ample sensitivity to detect tones in most every application.

The MM-VT1 board comes optionally without the speech synthesizer and parallel port for applications which only require Touch-Tone sending and receiving. PMMI can also supply a ribbon cable to plug into the parallel port header that is terminated with a standard DB-25 connector. The cable comes in two foot lengths only.

4.0 FCC REGISTRATION

4.1 PART 68

A few years ago, all equipment connected to the public switched network had to be supplied by the phone company. This is no longer the case. The Federal Communications Commission (FCC) has ruled that devices not supplied by the telephone companies may be connected to the telephone system, provided that certain requirements are met. This registration of the MM-VT1 required an extensive design and testing effort, and submission to the FCC of a lengthy application and test report.

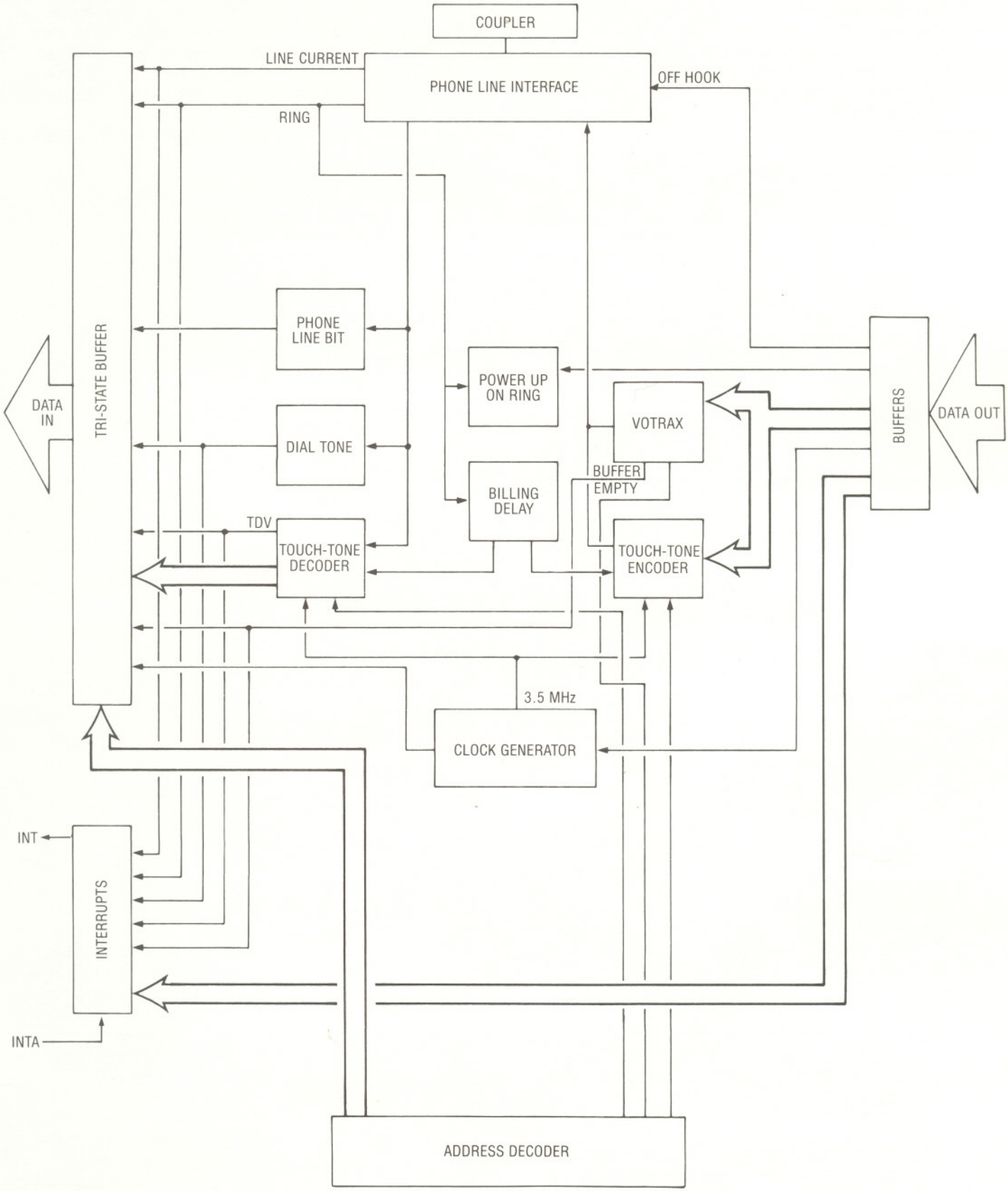
For connection of any device to the telephone network to be legal in the eyes of the FCC, connection must be accomplished either through an FCC-approved Data Access Arrangement (DAA - CBT or CBS) or the device itself must be approved by the FCC for direct connection. In either case, certain functions must be accomplished to prevent "harm" to the telephone system:

1. High voltage introduced into the telephone cable must be prevented from reaching the telephone office and damaging expensive equipment.
2. The telephone line must be kept "balanced" so that interference to and from other users is minimized.
3. Timing functions necessary for proper operation of the phone company billing equipment must be accomplished.
4. High frequency signals must not be allowed to enter the phone system.
5. The amount of signal power that the user can introduce into the phone system must be controlled.

There are presently a relatively large number of devices illegally connected to the telephone network. These devices not only violate federal regulations, but in most cases the method of connecting fails to protect the user's equipment (e.g., from high voltage surges introduced into the telephone cables during electrical storms).

The MM-VT1 accomplishes all the protective functions required by the FCC. It uses a miniaturized, protective coupler (to keep any possible high voltages away from your computer) and proprietary on-board circuitry to accomplish billing delay and level control. The MM-VT1 removes the need for a DAA and allows you to make a legal, direct connection satisfactory to both the FCC and the phone company. The design of the MM-VT1 has been accomplished in such a way that not only is the DAA avoided, but the cost of the DAA is also removed.

3.1 MM-VT1 BLOCK DIAGRAM



4.2 PART 15

More recently, the FCC has required manufacturers to check their products for RFI/EMI (Radio Frequency Interference/Electro Magnetic Interference). Basically, this tests for emitted radio energy from your computer and accessories to prevent your computer from interfering with radios or televisions that are in close proximity. PMMI has had the MM-PC1 (our protective coupler) tested according to Part 15.

The MM-PC1 is the only part of your MM-VT1 that should be outside of your computer. (See installation instructions for specifics on installing your MM-VT1 and coupler.) If installed properly, the MM-VT1 and coupler will not change the characteristics of your computer. If you are in possession of a non-complying computer, our device will not make its performance worse. Conversely, it will not improve its performance. If you possess a Part 15-approved computer, the MM-VT1 and coupler will not adversely affect its performance in relation to RFI/EMI.

There are two types of FCC Part 15 testing: Class A and Class B. Class A is called a verification. Class B is referred to as certification. Verification requirements are less stringent than those for certification, and are intended for commercial or business environments. Certification is very stringent and is applied to 'home computers.'

The MM-PC1 has been verified as a Class A computing device and is suitable for business or commercial environments. In the process of testing the MM-PC1, we found it to be extremely "quiet," sufficiently so that it probably would not cause interference even in a home environment if installed according to the instructions in this manual.

5.0 INSTALLATION INSTRUCTIONS

Installing your MM-VT1 and coupler will be, in most cases, a fairly quick and easy process. Below, we have listed some steps that you may have to consider. If you require more information than listed below please refer to Section 6.0, Technical Characteristics, or call PMMI.

5.1 BUS INTERFACE

The MM-VT1 meets the IEEE 696 standard for a bus interface. Operational speed capability is in excess of 10 MHz. The MM-VT1 is a 'simple' I/O device and will probably work in almost all pre-IEEE 696 computers.

5.2 MM-PC1 PROTECTIVE COUPLER

The beige box with the light-emitting diode (MM-PC1) is installed on the outside of your computer as follows:

1. The ribbon cable with the 14 pin plug is inserted through an extra connector hole in the back of the computer. When the coupler is attached to the back of the computer (via double-sided tape, not included) or laid as close as possible to the computer, only 1 - 2 inches of ribbon cable should be exposed. If your computer has no extra connector hole, you may run the cable out through the space between the computer and its cover. Again, the exposed ribbon cable outside the computer should be limited to 1 - 2 inches. A longer amount of exposed cable will not prohibit use, but may effect the amount of radio interference radiated by your computer. The adverse effect would be to radio and television reception in close proximity to the computer.
2. Coil the extra cable up inside your computer and tie it with a rubber band or other non-conducting, lint-free material.
3. The 14 pin plug attaches to the MM-VT1 in the 14 pin socket labeled "coupler" on the upper left edge of the board. The cable will come off the top of the board away from the bus when it is positioned correctly. Be sure all pins are properly aligned before pressing the plug in.
4. Attach the 7 foot phone line cord (supplied with your MM-VT1) to the telephone coupler and to the phone company's wall connection.
5. Finally, coil the excess cord and place it behind the computer.

If you follow these installation instructions, you will not increase the RFI emissions from your computer. See additional information in Section 4.0, FCC Registration.

5.3 INFORM THE PHONE COMPANY

You must inform the local phone company that you have installed an additional device to your phone service. See the Section 1.0, Instructions to the User, for further details.

5.4 SET THE ADDRESS SWITCHES

The MM-VT1 uses four consecutive I/O ports in the 8 bit I/O space. See the instruction manual for your computer (or contact the manufacturer) to determine where additional I/O space exists in your computer. Your computer will have either 256 or 65536 possible I/O spaces, so the MM-VT1 (with only 4) should be easily accomodated. See Section 7.0, Theory of Operation for directions to set the switches. D4-D7

We ship the board for locations C4 - C7 hex, or switch positions on, on, off, off, off, on. If you have any additional questions or need further assistance, please call us.

6.0 TECHNICAL CHARACTERISTICS

Speech synthesizer	Phoneme type (unlimited vocabulary) with pitch control
DTMF encoder	Allows for generation of all 16 digits(0-9 & A-D)
DTMF decoder	Receives all 16 digits Detection time 40 ms Sensitivity -36 +/-2 dBm High 60 Hz rejection Dynamic range 36 dB
Dial tone/remote ring detector	440 Hz tone decoder Bandwidth approx.=44 Hz @-13 dBm Can be adjusted for other frequencies
Interrupts (maskable)	1. Votrax buffer empty 2. Decoder tone valid 3. Timer pulses 4. Dial tone or ring 5. Line current acknowledgable in software
Parallel I/O port	8 open collector outputs at up to 30v and 30 ma 8 TTL level inputs. Supply current +5v 400 ma +12v 500 ma -12v 600 ma
Line current detector	for determining remote phone answer works mainly on ESS exchanges
Phone line bit	A 1 bit A/D to detect sound on the line
Pulse dialer	60/40 duty cycle w/selectable 10 or 20 Hz dialing rate

Current drain	With speech	Without speech
+5v	390 ma	280 ma
+12v	86 ma	74 ma
-12v	13 ma	13 ma

FCC registered	Reg #BJ686B-70323-OT-E Ring equiv. 0.4A Connects with RJ11C modular jack
IEEE 696/S-100	Meets all specifications Requires 4 consecutive I/O ports

Operation to greater than 10 MHz

7.0 THEORY OF OPERATION

7.1 GENERAL

The MM-VT1 is compatible with the IEEE 696 standard for the S-100 bus and, through the protective coupler, connects directly to an RJ11C modular jack. The board has three major independent functions plus several minor ones which allow it to interface directly with the telephone system and communicate with a remote user. The first of these major functions is speech synthesis, allowing the computer to talk to a user equipped with nothing more than a Touch-Tone phone. The other two major functions are Touch-Tone encoding for dialing and Touch-Tone decoding for receiving tones from the remote user's phone.

Other functions include: dial tone/remote ring detect (to avoid "blind dialing" and to allow for counting rings on the remote end when originating calls), ring detect (for auto answer), computer power on at ring, and clear to send output to indicate the end of the billing delay. A parallel port controls and observes external devices. A line current detector determines the status of the remote caller. A telephone line bit determines if there is any sound on the line. A 40/60 duty cycle output at a rate of 10 or 20 Hz (selectable) is used as a reference for pulse dialing. A protective coupler allows direct connection to the telephone line. Maskable interrupts allow interrupt control of the board.

7.2 SPEECH SYNTHESIZER

The Votrax SC-01A is a phoneme-type speech synthesizer which contains 64 different phonemes accessed by a 6 bit code. Another 2 bits select one of four inflection levels. A status bit indicates when the chip needs another phoneme.

7.3 TOUCH-TONE DECODER

The Silicon Systems SSI-201 is a stand-alone Touch-Tone receiver. It has eight internal bandpass filters and 60 Hz rejection on the front end to provide very sensitive tone detection of all 16 keys. Frequency stability is crystal controlled. Detection time is typically 25 ms with pauses of 32 ms in between digits as a necessity. The output consists of 4 bits of data and a status bit to indicate when the output is valid.

7.4 TOUCH-TONE ENCODER

The Touch-Tone encoder is the Mostek MK5089, which can generate tones for all 16 keys. It uses row and column inputs to select tones, so in order to allow only 4 bits to generate a particular pair of tones, the circuit has a couple of 2 to 4 decoders. There is also a bit to turn the tones on and off. Again, frequency stability is crystal controlled.

7.5 DIAL TONE DETECTOR

The dial tone detector circuit consists of an NE567 tone decoder chip which is factory set to 440 Hz (one of the two frequencies that makes up the dial tone). Ring return, which is the ringing sound you hear when calling out, also uses 440 Hz as one of the pair of tones, so the dial tone detector can also be used to determine if the remote phone is ringing. There is an adjustment to change the frequency the decoder will detect. See Tables 8.2.1 and 8.2.2 for a list of other useful frequencies and how to adjust the detector to decode them.

7.6 RING DETECTOR

The ring indication comes from the coupler. The signal goes through an integrator/amplifier to eliminate noise, and then goes directly onto the bus as a status bit. This allows the software to count rings and determine when to answer.

7.7 LINE CURRENT

Line current comes from the telephone line coupler. This signal is very handy when used on ESS exchanges. When the remote telephone is answered, there is a change in line current. Hence, this bit indicates when the person or computer being called has answered the phone. This signal is fed into an on-board integrator and transistor switch and then goes to a tri-state buffer connected to the bus.

NOTE: Because of the nature of this bit, no software examples have been provided. This bit is useful when calling an ESS exchange from an ESS exchange. When the remote station answers, the caller will experience a momentary break in line current. If you wish to use this bit, we encourage you to experiment with it. If you are writing custom software, remember that since operation of this function is dependent on the type of exchange you are calling from and to, the operation may vary at different locations. Call us if you have further questions.

7.8 PHONE LINE BIT

The phone line bit is the output of a voltage comparator with an input coupled to the audio on the telephone line. It can be used in a variety of ways to help in determining the status of the phone line. It can be used to verify dial tone detect by checking for audio on the line after the dial tone bit has detected dial tone.

Use this bit to look for other tones on the phone line or to check the Touch-Tone generator. It can also be used to determine if the number called is busy or was incorrectly dialed. When originating a call, it can be used to tell when the remote user has finished saying "hello."

7.9 TIMER PULSES

The timer pulse bit can be used as a timing reference for dialing or any kind of CPU independent timing. A bit on output port Relative 0 selects 10 or 20 pulses per second and the duty cycle is 60/40 (required by the phone company).

7.10 INTERRUPTS

Interrupts are maskable and optionally software or

hardware acknowledged. Although the interrupt output factory is jumpered to the standard interrupt line, it can be jumpered by the user to one of the vectored interrupt lines for systems which have multiple boards generating interrupts. Interrupt options are available on dial tone/ring detect, timer pulse, votrax buffer empty, tone decoder output valid and line current break.

7.11 BILLING DELAY

The FCC requires that the Touch-Tone encoder and decoder be disabled for at least 2 seconds after answering an incoming call. This prevents data transfer until the billing equipment has determined that the call went through. The CTS (clear to send) bit indicates when the billing delay is over.

7.12 PARALLEL PORT

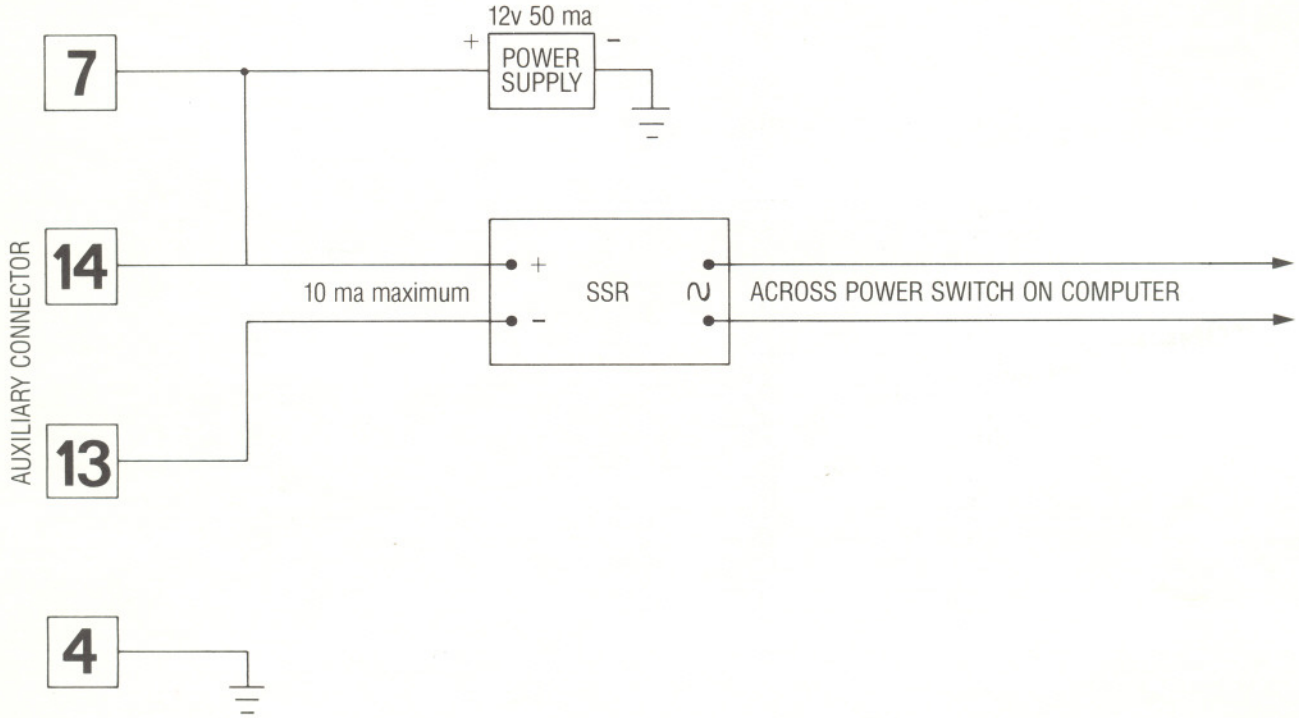
There is a parallel I/O port which can be used to control external devices and sense external inputs. The outputs are open collector high voltage TTL, suitable for driving small relays. Inputs are TTL level. I/O is via a 26 pin header at the top of the board which also provides +5v, +/-12v, and ground. See the table in Section 8.6 for pin outs of the header.

7.13 POWER UP ON RING

The MM-VT1 has built-in capability for powering up your computer automatically upon the phone's ring. Additional parts required include one low current +12v power source (50 ma output is fine), a solid state relay capable of powering your computer and only drawing 10 ma on the input @12v and the wire to hook up the relay and power supply to the MM-VT1. The connections are fairly simple and use the auxiliary connector as shown in the example schematic below.

Once the circuit is connected, the power supply will power the ring detector in the coupler. When the phone rings the solid state relay will close, turning on the computer, and will remain on until you output Bit 7 high on port Relative 1. The small power supply will power the solid state relay when the computer is on. Be sure your computer implements Power On Clear on pin 99 of the S-100 bus or this circuit will not work properly.

7.13.1 POWER UP USING SOLID STATE RELAY



8.0 ADJUSTMENTS

There are five factory-set potentiometers on the board at the top right labelled PLB, DTD, TL, VL and VP.

8.1 PHONE LINE BIT (PLB)

This pot is used to adjust the sensitivity of the phone line bit and reduce the effect of noise. It is factory preset at a point where a normal voice will trigger it. The pot adjusts the reference voltage of a voltage comparator. Turning the pot clockwise increases sensitivity.

8.2 DIAL TONE DETECT (DTD)

The center frequency of the dial tone decoder circuit

can be shifted by adjusting this pot. Turning the pot clockwise increases the frequency it detects. It is factory set to 440 Hz for detecting dial tone and audible ringing tone (ring back).

R7 can be replaced to allow for different frequency ranges. The table below contains all the tones that are useful to decode.

8.2.1 Table of Proposed Standard of Audible Tones in North America

(from CCITT Document AP III-84)

	Frequencies (hertz)				Power per Frequency at Exchange Where Tone is Applied	
Use	**350**	**440**	**480**	**620**	**(dBm0)**	**Cadence**
Dial tone	x	x			-13	continuous
Busy tone			x	x	-24	0.5 sec. on 0.5 sec. off
Reorder tone			x	x	-24	0.2 sec. on 0.3 sec. off or 0.3 sec. on 0.2 sec. off
Audible ringing		x	x		-16	2 sec. on 4 sec. off
Call Waiting		x			-13	single 500 ms pulse

8.2.2 R7 Values for Frequencies

Center Frequency of Detector (in Hz)	Approximate Value of R7 (in ohms)
350	30k
440	22k
480	20k
620	16k

8.3 TONE LEVEL (TL)

The Touch-Tone encoder output volume can be turned down if it is found to be too loud by using this pot. The pot is adjusted counter-clockwise to lower volume. It is factory-set at the loudest point to assure error-free dialing. Louder levels are not possible because of FCC limitations.

8.4 VOTRAX LEVEL (VL)

This pot affects the output level of the speech synthesizer. It is factory-set to the loudest point. To decrease volume, the pot is turned counter-clockwise. Like the tone level, the votrax level cannot be adjusted louder because of FCC limitations.

8.5 VOTRAX PITCH (VP)

The base pitch of the votrax can be adjusted to affect the type of voice generated (ie, male or female) via this pot. Adjusting this pot also changes the speed at which the synthesizer 'talks.' It is factory set to a reasonably natural-sounding voice. Higher pitched voices are accomplished by turning the pot clockwise.

8.6 PINOUTS FOR PARALLEL PORT

PIN NUMBER ON HEADER	FUNCTION	PIN # ON DB-25 CONNECTOR
1	N.C.*	1
2	N.C.*	14
3	N.C.*	2
4	N.C.*	15
5	GROUND	3
6	GROUND	16
7	-12v	4
8	+12v	17
9	+5v	5
10	INPUT BIT 0	18
11	INPUT BIT 1	6
12	INPUT BIT 2	19
13	INPUT BIT 3	7
14	INPUT BIT 4	20
15	INPUT BIT 5	8
16	INPUT BIT 6	21
17	INPUT BIT 7	9
18	OUTPUT BIT 0	22
19	OUTPUT BIT 1	10
20	OUTPUT BIT 2	23
21	OUTPUT BIT 3	11
22	OUTPUT BIT 4	24
23	OUTPUT BIT 5	12
24	OUTPUT BIT 6	25
25	OUTPUT BIT 7	13
26	N.C.	N.C.

*Connected to pads on board for optional customizing to your specific requirements.

9.0 ADDRESS SELECTION

The board requires 4 seclusive I/O ports and is addressed by a 6 position dip switch. The table below covers all the possible switch settings along with the base address associated with each.

SWITCH POSITION	HEX ADDR.	SWITCH POSITION	HEX ADDR.	SWITCH POSITION	HEX ADDR.
OOOOOO	00	OCOCOC	54	COCOCO	A8
OOOOOC	04	OCOCCO	58	COCOCC	AC
OOOOCO	08	OCOCCC	5C	COCCOO	B0
OOOOCC	0C	OCCOOO	60	COCCOC	B4
OOOCOO	10	OCCOOC	64	COCCCO	B8
OOOCOC	14	OCCOCO	68	COCCCC	BC
OOOCCO	18	OCCOCC	6C	CCOOOO	C0
OOOCCC	1C	OCCCOO	70	CCOOOC	C4
OOCOOO	20	OCCCOC	74	CCOOCO	C8
OOCOOC	24	OCCCCO	78	CCOOCC	CC
OOCOCO	28	OCCCCC	7C	CCOCOO	D0
OOCOCC	2C	COOOOO	80	CCOCOC	D4
OOCCOO	30	COOOOC	84	CCOCCO	D8
OOCCOC	34	COOOCO	88	CCOCCC	DC
OOCCCO	38	COOOCC	8C	CCCOOO	E0
OOCCCC	3C	COOCOO	90	CCCOOC	E4
OCOOOO	40	COOCOC	94	CCCOCO	E8
OCOOOC	44	COOCCO	98	CCCOCC	EC
OCOOCO	48	COOCCC	9C	CCCCOO	F0
OCOOCC	4C	COCOOO	A0	CCCCOC	F4
OCOCOO	50	COCOOC	A4	CCCCCO	F8
				CCCCCC	FC

C=Closed Switch (ON) O=Open Switch (OFF)

NOTE: These switch settings are the complements of those for the MM-103.

10.0 CONTROL REGISTER DETAILS

10.1 DATA OUT REGISTERS

10.1.1 Register at Relative Address 0

Bits 0-3: Encoder Digit

These 4 bits select one of 16 Touch-Tones to be sent. The table below is the digit translation scheme.

Digit to be Dialed = Hex # Out

1=0	2=4	3=8	A=C
4=1	5=5	6=9	B=D
7=2	8=6	9=A	C=E
*=3	0=7	#=B	D=F

Bit 4: Tone Enable

This bit, when low, enables the Touch-Tone encoder, allowing it to generate a tone. When high the encoder output is off.

Bit 5: Votrax Enable

When high, this bit enables the Votrax. Setting this bit low while the votrax is talking sets all additional phonemes to a 3F hex which is a 'STOP'.

Bit 6: Timer Pulse Select

This bit selects the timer pulse rate. When low, the timer pulse output rate is 10 pulses per second. Selecting 20 pps is done by setting this bit (high).

Bit 7: Decoder Enable

When high, this bit enables the Touch-Tone decoder to receive and decode Touch-Tones. This bit should be low when dialing.

10.1.2 Register at Relative Address 1

Bits 0-4: Interrupt Masks

Bit 0, when set (high), causes an interrupt to be generated when the decoder has detected a valid digit.

Bit 1, when set, generates an interrupt when the Votrax needs another phoneme.

Bit 2 causes an interrupt on the rising edge of the timer pulses.

Bit 3 generates an interrupt when dial tone or ring is detected.

Bit 4 generates an interrupt on the rising edge of line current.

Bit 5: Enable Interrupts

When this bit is set, interrupts are enabled. This bit can also be used as an interrupt acknowledge by pulsing it low. Holding it low will disable the interrupts.

10.0.1 CONTROL REGISTERS

DATA OUT

7	6	5	4	3	2	1	0	
OPEN COLLECTOR PARALLEL OUT								3
V7	V6	V5	V4	V3	V2	V1	V0	2
POWER DOWN	OFF HOOK	$\overline{\text{INTA}}$	LINE CURRENT INTERRUPT	DIAL TONE AND RING DETECT INTERRUPT	TIMER PULSE INTERRUPT	VOTRAX BUFFER EMPTY INTERRUPT	TONE VALID INTERRUPT	1
DECODER ENABLE	TIMER PULSE SELECT (L=10PPS, H=20PPS)	VOTRAX ENABLE	$\overline{\text{TONE}}$ ENABLE	T3	T2	T1	T0	0

DATA IN

7	6	5	4	3	2	1	0	
TTL PARALLEL IN								3
NOT USED								2
100 HZ	TIMER PULSES	CTS	TDV	6 SECOND RING TIME OUT	$\overline{\text{DIAL TONE}}$	PHONE LINE BIT	$\overline{\text{LINE CURRENT}}$	1
$\overline{\text{DIAL TONE AND RING DETECT}}$	TIMER PULSES	VOTRAX BUFFER EMPTY	TDV	T3	T2	T1	T0	0

Jumper J2 is used to disable hardware interrupt acknowledge.

In systems that have more than one board generating interrupts, hardware acknowledge must be disabled to prevent one board's 'acknowledge' from clearing another board's pending interrupt. To make this modification, cut the track between the top pad and the pad on the lower right, and put a jumper across the lower left pad and the top pad.

Bit 6: Off Hook

Bringing this bit high will take the phone off hook. This bit is also used for pulse dialing.

Bit 7: Power Down

This bit is used in conjunction with a solid state relay to power down the computer after a phone ring automatically powers it up. See the diagram and description in Section 7.13, Power Up on Ring.

10.1.3 Register at Relative Address 2

Bits 0-5: Phoneme Selection

These 6 bits go to the Votrax buffer for generating a particular phoneme. The table below has a list of all the phonemes. See the enclosed dictionary for assistance in sound and word formation.

10.1.3.1 PHONEME SELECTION CHART

(from Votrax Data Sheet)

PHONEME CODE	PHONEME SYMBOL	DURATION (MS)	EXAMPLE WORD
00	EH3	59	jacket
01	EH2	71	enlist
02	EH1	121	heavy
03	PA0	47	no sound
04	DT	47	butter
05	A2	71	made
06	A1	103	made
07	ZH	90	azure
08	AH2	71	honest
09	I3	55	inhibit
0A	I2	80	inhibit
0B	I1	121	inhibit
0C	M	103	mat

PHONEME CODE	PHONEME SYMBOL	DURATION (MS)	EXAMPLE WORD
0D	N	80	sun
0E	B	71	bag
0F	V	71	van
10	CH*	71	chip
11	SH	121	shop
12	Z	71	zoo
13	AW1	146	lawful
14	NG	121	thing
15	AH1	146	father
16	OO1	103	looking
17	OO	185	book
18	L	103	land
19	K	80	trick
1A	J**	47	judge
1B	H	71	hello
1C	G	71	get
1D	F	103	fast
1E	D	55	paid
1F	S	90	pass
20	A	185	day
21	AY	65	day
22	Y1	80	yard
23	UH3	47	mission
24	AH	250	mop
25	P	103	past
26	O	185	cold
27	I	185	pin
28	U	185	move
29	Y	103	any
2A	T***	71	tap
2B	R	90	red
2C	E	185	meet
2D	W	80	win
2E	AE	185	dad
2F	AE1	103	after
30	AW2	90	salty
31	UH2	71	about
32	UH1	103	uncle
33	UH	185	cup
34	O2	80	for
35	O1	121	aboard
36	IU	59	you
37	U1	90	you
38	THV	80	the
39	TH	71	thin
3A	ER	146	bird
3B	EH	185	get
3C	E1	121	be
3D	AW	250	call
3E	PA1	185	no sound
3F	STOP	47	no sound

*T must precede CH to produce "CH" sound.
**D must precede J to produce "J" sound.
***PA0 must follow T to produce "T" sound at the end of a word.

Bits 6 & 7: Pitch Control

These two bits select the pitch to go along with the selected phoneme. 00 selects the lowest pitch, 01 the next higher, 10 the next to highest and 11 selects the highest pitch. These two bits will select the pitch for each phoneme. The pitch cannot be changed during the 'speaking' of a phoneme.

10.1.4 Register at Relative Address 3

Bits 0-7: Parallel Output

These 8 bits go directly to the 26 pin header through high voltage open collector TTL inverters. The outputs are also latched. On power up, they are set (high).

10.2 DATA IN REGISTERS

10.2.1 Register at Relative Address 0

Bits 0-3: Decoder Output

These 4 bits are the Touch-Tone decoder outputs. The table below shows the translation from digit received to output of the decoder in hex.

1=1	2=2	3=3	A=D
4=4	5=5	6=6	B=E
7=7	8=8	9=9	C=F
*=B	0=A	#=C	D=0

Bit 4: Tone Valid

This bit is set when the decoder outputs are valid. It is cleared immediately after the port is read. It will not be set again until another valid tone has been received.

Bit 5: Votrax Buffer Empty

When high, this bit indicates that the votrax buffer is empty. As a result of the double buffering on the phoneme/pitch output port (Relative output port 2), this bit will go high, signalling you to write another phoneme into the buffer while the synthesizer is in the process of speaking. This allows the computer some reaction time to write out the next phoneme. This may be required to keep smooth speech on some higher level languages. The exact reaction time is the duration of the phoneme the synthesizer is in the process of speaking. If a new phoneme is not written out in time, the votrax will repeat the last one again. See 10.1.3.1, Phoneme Selection Chart, for approximate duration of each phoneme.

Bit 6: Timer Pulses

This is the timer pulse output for dialing reference. The duty cycle is 40/60 (40 high, 60 low). For the most reliable dialing, on hook should be 60%.

Bit 7: Dial Tone/Ring Detect

To save space in the mapping of the status bits, Dial Tone and Ring Detect have been ANDed together. When low, this bit indicates the presence of dial tone, given that the phone is off hook. If the phone is on hook and this bit goes low, it indicates phone ringing.

10.2.2 Register at Relative Address 1

Bit 0: Line Current

This bit indicates the line current status. The bit goes low when there is current on the line.

Bit 1: Phone Line Bit

The phone line bit helps determine when there is someone talking on the line. It measures duration of busy signal and other related signals. This can be used to determine when it is okay for the votrax to talk. See Section 12.4.5 for a program to set PLB.

Bit 2: Dial Tone

This bit indicates the presence of dial tone only when low. This is provided for ease of programming when used with Bit 7 of Port 0. In this way, it is not necessary for the software to remember whether or not the phone is off hook.

Bit 3: Six Second Timer

The six second timer is used by the board to determine mode. When the phone rings, the timer starts. If the board is software-directed to go off hook before the timer runs out, it goes into answer mode. This simply means that the Touch-Tone encoder and decoder are disabled for about two seconds for billing delay purposes.

Bit 4: Tone Valid

This bit is the same as Bit 4 of Port 0 except that it is *not* cleared on either port after the read. This is a nice feature when programming in a language that allows conditional statements to poll I/O ports since there is no need to store the value of the port to verify that its contents are valid.

Bit 5: CTS

On incoming calls, this bit will indicate the billing delay by going low and then going back high when the delay is over and the encoder and decoder are enabled.

Bit 6: Timer Pulses

This bit is the same as Bit 6 on Port 0. It is duplicated here so that the timer pulses can be used for timing loops without the risk of possibly clearing an incoming Touch-Tone.

Bit 7: 100 Hz Oscillator

This bit is tied to a 100 Hz oscillator. It can be used for software timing of odd dialing rates, tighter timing loops, etc.

10.2.3 Register at Relative Address 2

Register at Relative Address 2 is not used.

10.2.4 Register at Relative Address 3

Bits 0-7: Parallel Input

These 8 bits are TTL level inputs and are for external inputs to the board. See the Table 8.6 for the pinouts of the parallel port.

11.0 TROUBLE SHOOTING

This table can help determine and correct most correctable user problems. If further assistance is needed, or you find a problem not covered in the table, please call our technical staff. They will gladly provide you with more extensive help. If it is determined that the board should be sent back to PMMI for repairs, refer to Section 2.0, Instructions for Return of MM-VT1 for Repair.

PROBLEM	CAUSE/SOLUTION
BOARD DOES NOT WORK AT ALL, NO TIMER PULSES, DOESN'T GO OFF HOOK.	The board is not addressed where the software thinks it is. Check the address switches on the board and make sure the software is using the same address. OR The board is addressed at the same location as another I/O card in the computer. Check the address locations of the other cards in the system. If there is a conflict, the MM-VT1 will have to be readdressed and the software modified.
BOARD WILL NOT GO OFF HOOK, INDICATED BY THE COUPLER LIGHT NOT COMING ON.	Coupler may not be connected properly to the phone line or to the board. Make sure the ribbon cable is plugged into the left socket on the board with the cable coming out of the top of the plug.
BOARD WILL NOT DETECT DIAL TONE.	Check the cord from the coupler to the phone line. If possible, use an extension phone to determine whether or not the phone line is operating properly. Use the example software to check the dial tone detector adjustment.
BOARD DETECTS FALSE DIAL TONE.	Check the software to determine that it's letting the noise settle after going off hook. Also check the dial tone adjustment.
SPEECH SYNTHESIZER IS NOT WORKING.	Check the base pitch adjustment. Also check the volume.
SPEECH SYNTHESIZER IS NOT UNDERSTANDABLE.	Check the base pitch adjustment.
TOUCH-TONE DECODER IS NOT DETECTING TONES.	The software must first enable the decoder in order for the decoder to work. Additionally, the software must wait for CTS to come on before the decoder will work.
TOUCH-TONE ENCODER IS NOT DIALING PROPERLY, OR IS NOT DIALING AT ALL.	Check volume adjustment. Make sure the software is waiting for CTS. Verify that the software is putting quiet space between the tones.
THE PHONE LINE BIT (PLB) IS NOT WORKING.	The sensitivity may be adjusted too low.
THE PLB IS VERY NOISY.	The sensitivity may be adjusted too high.

12.0 SOFTWARE EXAMPLES

12.1 GENERAL

The software in this manual is intended to help the programmer understand the functions of the MM-VT1, and to help in diagnosing any problems that may occur with the board. The BASIC programs are written in Microsoft's BASIC-80 release 5.0. Assembly language routines are written for the CP/M Assembler.

The software in this manual, along with a written English-to-phoneme translator program, is available from PMMI on an 8 inch IBM-format disk for $25.00 plus shipping.

12.2 TOUCH-TONE DIALING

12.2.1 DIALER.BAS

This program demonstrates the Touch-Tone dialing capability of the MM-VT1. Variables are defined at the beginning of the program to make the code easier to read and understand. After you enter the number to be dialed, the routine translates the digits into the appropriate values to be sent to the board and stores them in an array. After completing the translation, the software takes the phone off hook and listens for the dial tone. It verifies that the tone is dial tone and not just line noise, then proceeds to dial the number.

The appropriate tones are generated at a rate of 10 pulses per second. This is accomplished by waiting for the rising edge of the timer pulse output to turn on the tone and turn it back off at the falling edge.

```
10 REM  ********************************************************
15 REM  *                                                      *
20 REM  *          TOUCH-TONE DIALING PROGRAM                  *
30 REM  *                                                      *
40 REM  ********************************************************
50 REM
60 REM
70 REM   THIS PROGRAM ASKS FOR A NUMBER,GOES OFF HOOK, WAITS FOR
80 REM   DIAL TONE, AND DIALS THE NUMBER.
90 REM
100 REM
110 DIM N(100)
120 R0=&HC4 : R1=R0+1 : R2=R0+2 : R3=R0+3
130 B0=1 : B1=2 : B2=4 : B3=8 : B4=16 : B5=32 : B6=64 : B7=128
140 OUT R0,B4 : OUT R1,0                    : REM RESET EVERYTHING
150 D$="147*2580369#ABCD"
160 INPUT "PLEASE ENTER THE NUMBER TO BE DIALED : ";A$
170 REM FROM HERE DOWN TO LINE 270 CONVERTS A$ INTO THE CORRECT DIGITS
180 C=1
190 FOR X=1 TO LEN(A$)
200 FOR Y=0 TO 15
210 IF MID$(A$,X,1)=MID$(D$,Y+1,1) THEN 250
220 NEXT Y
230 PRINT "INVALID CHAR -";MID$(A$,X,1);"- IGNORED"
240 GOTO 270
250 N(C)=Y
260 C=C+1
270 NEXT X
280 OUT R1,B6                               : REM GO OFF HOOK
290 FOR R=1 TO 50 : NEXT R                  : REM LET NOISE SETTLE
300 IF (INP(R1) AND B2)=B2 THEN 300         : REM WAIT FOR DIAL TONE
310 FOR R=1 TO 50 : NEXT R                  : REM KILL MORE TIME
320 IF (INP(R1) AND B2)=B2 THEN 300         : REM MAKE SURE ITS REAL
330 REM
340 REM TOUCH-TONES WILL BE SENT ON THE RISING EDGE OF EACH
350 REM TIMER PULSE AND TURNED OFF A THE FALLING EDGE.
360 REM
```

```
370 FOR X=1 TO C-1
380 IF (INP(R0) AND B6)=0 THEN 380
390 IF (INP(R0) AND B6)=B6 THEN 390   : REM NOW WAIT FOR IT TO GO HIGH
400 OUT R0,N(X)                       : REM OUTPUT TONE
410 IF (INP(R0) AND B6)=0  THEN 410   : REM WAIT FOR FALLING EDGE
420 OUT R0,B4                         : REM TURN OFF TONE
430 NEXT X
```

12.2.2 TTDIAL.ASM

This Assembly language routine is functionally the same as the previous routine in BASIC. It can be assembled using the CP/M assembler.

```
CR      EQU     0DH             ; return
LF      EQU     0AH             ; line feed
R0      EQU     0C4H            ;relative port address. Change
R1      EQU     R0+1            ; this to suit the address
R2      EQU     R0+2            ; on your board.
R3      EQU     R0+3

NOTONE  EQU     10H             ; Touch-Tone output enable bit.
DITONE  EQU     4               ; dial tone bit
OFHOOK  EQU     40H             ; off hook bit
TIMER   EQU     40H             ; timer pulse output
WMBOOT  EQU     0               ; cpm warm boot jump location
CONBUF  EQU     0AH             ; cpm console buffer
PRMESS  EQU     9               ; cpm print message pointer
CONOUT  EQU     2               ; cpm console output pointer
CONIN   EQU     1               ; cpm console input pointer

CPM     EQU     5               ; cpm I/O jump location

        ORG     100H

        MVI     A,NOTONE        ; reset everything
        OUT     R0
        XRA     A
        OUT     R1
        LXI     D,MES1          ; ask for number to be entered
        MVI     C,PRMESS
        CALL    CPM
        LXI     D,NUMBER        ; let him type it in.
        MVI     C,CONBUF
        CALL    CPM
        LXI     D,MES4          ; say waiting for dial tone
        MVI     C,PRMESS
        CALL    CPM
        MVI     A,OFHOOK        ; go off hook
        OUT     R1
        MVI     B,5             ; wait a half a second
        CALL    WAIT
```

```
DTD     IN      R1              ; do we have dial tone ?
        ANI     DITONE
        JNZ     DTD             ; loop if not
        MVI     B,3             ; dial tone detected,
        CALL    WAIT            ; wait for .3 sec
        IN      R1              ; and check to make sure its
        ANI     DITONE          ; still there to avoid noise
        JNZ     DTD
        LXI     D,MES5          ; say dialing
        MVI     C,PRMESS
        CALL    CPM
        LXI     D,NUMBER+1      ; DE points to digit to be dialed
        MVI     A,0             ; A is how many digits have been
START   LXI     H,NUMBER+1      ; loc of number of digits entered
        CMP     M               ; if they're the same, we're done
        JZ      PEND
        INR     A               ; another digit dialed
        INX     D               ; DE now points to num to be dialed
        PUSH    PSW             ; save A
        LDAX    D               ; get the number to be dialed
        PUSH    D               ; save DE
        MVI     B,0             ; clear B
        MVI     C,10H           ; 16 possible keys
        LXI     H,TBL
LOOP    CMP     M               ; if it matches whats in table
        JZ      DIAL            ; then dial it
        INX     H               ; else, check next table entry
        INR     B
        DCR     C               ; when C counts down we're done
        JNZ     LOOP            ; looking thru the table
        LXI     D,MES2          ; which means an incorrect char
        MVI     C,PRMESS        ; was entered
        PUSH    PSW
        CALL    CPM
        POP     PSW
        MOV     E,A             ; print wrong char
        MVI     C,CONOUT
        CALL    CPM
        LXI     D,MES3          ; say it was ignored
        MVI     C,PRMESS
        CALL    CPM
        POP     D               ; get back DE and A
        POP     PSW
        JMP     START           ; and go back for another number

DIAL    MOV     E,A             ; print number about to be dialed
        MVI     C,CONOUT
        PUSH    B               ; save value to be sent to board
        CALL    CPM
        POP     B               ; get it back
```

```
DIAL1   IN      R0              ; wait until timer pulses go low
        ANI     TIMER
        JNZ     DIAL1
RISE    IN      R0              ; now wait for the rising edge
        ANI     TIMER
        JZ      RISE
        MOV     A,B             ; and output the tone
        OUT     R0
FALL    IN      R0              ; until timer pulses go low again
        ANI     TIMER
        JNZ     FALL
        MVI     A,NOTONE        ; then turn off the tone
        OUT     R0
        POP     D               ; get back DE and A
        POP     PSW
        JMP     START           ; and go for another one

PEND    LXI     D,MES6          ; say disconnecting
        MVI     C,PRMESS
        CALL    CPM
        MVI     C,CONIN         ; when you hit return
        CALL    CPM
        XRA     A               ; and hang up
        OUT     R1
        JMP     WMBOOT          ; and quit

WAIT    IN      R0              ; wait for rising edge
        ANI     TIMER
        JZ      WAIT
WAIT1   IN      R0              ; wait for falling edge
        ANI     TIMER
        JNZ     WAIT1
        DCR     B               ; count off a 1/10 of a second
        RZ                      ; and return if done
        JMP     WAIT            ; otherwise loop

TBL     DB      '147*2580369#ABCD'

MES1    DB      CR,LF,LF,LF,'ENTER PHONE NUMBER TO BE DIALED : $'
MES2    DB      CR,LF,'INVAILD CHAR -$'
MES3    DB      '-  IGNORED.',CR,LF,'$'
MES4    DB      CR,LF,LF,'WAITING FOR DIAL TONE...',CR,LF,'$'
MES5    DB      CR,LF,LF,'DIAL TONE RECEIVED',CR,LF,'DIALING : $'
MES6    DB      CR,LF,LF,'PLEASE HIT RETURN TO DISCONNECT $'

NUMBER  DB      50H

        END
```

12.3 TOUCH-TONE DECODING

12.3.1 DECODE.BAS

This routine demonstrates the Touch-Tone receiving capability of the MM-VT1. Here again, variables are set to improve the readability of the code. The program waits for an incoming call. When it detects ring, the software pauses a second or two and then says "Hello. Enter Touch-Tones." At this point, the caller can start hitting keys on his Touch-Tone pad, and the program will receive and decode them. If the caller hits an *, the routine will hang up.

```
10 REM ************************************************************
20 REM *                                                          *
30 REM *              TOUCH-TONE DECODING DEMO PROGRAM            *
40 REM *                                                          *
50 REM ************************************************************
60 REM
70 REM
80 REM  THIS PROGRAM TAKES THE PHONE OFF HOOK ON RING, THE VOTRAX
90 REM  SAYS HELLO AND THEN RECEIVES AND DECODES TOUCH-TONES
100 REM AS THEY ARE ENTERED.
110 REM
120 R0=&HC4 : R1=R0+1 : R2=R0+2 : R3=R0+3
130 B0=1 : B1=2 : B2=4 : B3=8 : B4=16 : B5=32 : B6=64 : B7=128
140 REM
150 OUT R0,B4 : OUT R1,0                : REM RESET EVERYTHING
160 FOR R=1 TO 100 : NEXT R             : REM LET THINGS SETTLE
170 D$="D1234567890*#ABC"
180 IF (INP(R0) AND B7)=B7 THEN 180     : REM HANG UNTIL PHONE RINGS
190 OUT R1,B6                           : REM GO OFF HOOK
200 OUT R0,B5+B4                        : REM ENABLE VOTRAX
210 FOR R=1 TO 800 : NEXT R             : REM WAIT A LITTLE
220 IF (INP(R0) AND B5)=0 THEN 220      : REM WAIT FOR VOTRAX BUFF
225 REM                                     TO EMPTY
230 READ A                              : REM GET A PHONEME
240 OUT R2,A                            : REM AND SEND IT.
250 IF A<>63 THEN 220                   : REM IF NOT LAST THEN LOOP
260 OUT R0,B7+B4                        : REM ENABLE DECODER
265 REM                                     AND DISABLE VOTRAX
270 IF (INP(R1) AND B4)=0 THEN 270      : REM WAIT FOR A TONE TO
275 REM                                     BE RECEIVED
280 T=INP(R0) AND 15                    : REM GET TONE
290 PRINT MID$(D$,T+1,1);"  ";          : REM AND PRINT IT
300 IF T<>11 THEN 270                   : REM IF ITS NOT A STAR
305 REM                                     THEN LOOP
310 OUT R1,0                            : REM HANG UP
320 FOR R=1 TO 100 : NEXT R             : REM WAIT FOR LINE TO SETTLE
330 RUN
340 DATA  27,2,35,88,99,53,53,62,62,62,130,128,141,170,186,62,
350 DATA  106,114,99,106,80,42,53,55,13,18,63,63
```

12.3.2 TCODE.ASM

This Assembly language routine is functionally similar to the previous BASIC program. This program will assemble using the CP/M assembler.

```
;************************************************************
;*                                                          *
;*                TOUCH-TONE DECODING PROGRAM               *
;*                                                          *
;************************************************************
```

```
CR      EQU     0DH
LF      EQU     0AH
R0      EQU     0C4H
R1      EQU     R0+1
R2      EQU     R0+2
R3      EQU     R0+3
NOTONE  EQU     10H
OFHOOK  EQU     40H
TIMER   EQU     40H
WMBOOT  EQU     0
PRMESS  EQU     9
CONOUT  EQU     2
CONIN   EQU     1
CPM     EQU     5
TDV     EQU     10H             ; tone data valid bit decoder
TONE    EQU     0FH             ; the mask to get received tone
VOTRAX  EQU     20H             ; Votrax enable bit
RING    EQU     80H             ; ring detect bit
VBMT    EQU     20H             ; Votrax buffer empty
DECODE  EQU     80H             ; Touch-Tone decoder enable
CTS     EQU     20H             ; clear to send bit

        ORG     100H
        MVI     A,NOTONE+VOTRAX ; clear everything enable Votrax
        OUT     R0
        XRA     A
        OUT     R1
        MVI     A,63            ; silence the Votrax
        OUT     R2


        LXI     D,MES1          ; say  waiting for ring
        MVI     C,PRMESS
        CALL    CPM

        MVI     B,5             ; wait for everything to settle
        CALL    WAIT

ANSWER  IN      R0              ; is the phone ringing ?
        ANI     RING
        JNZ     ANSWER
        LXI     D,MES2          ; if so say so
        MVI     C,PRMESS
        CALL    CPM
        MVI     A,OFHOOK        ; and go off hook
        OUT     R1
        MVI     B,15            ; wait 1.5 seconds
        CALL    WAIT
        LXI     D,WORDS
SAYIT   IN      R0              ; is Votrax ready for phoneme
        ANI     VBMT
        JZ      SAYIT
        LDAX    D               ; get phoneme
        INX     D               ; point at the next one to be said
        OUT     R2              ; and say this one
```

```
        CPI     63              ; if it's a 63 then we are done
        JZ      TONES
        JMP     SAYIT           ; otherwise loop

TONES   IN      R1              ; now we have to wait for CTS
        ANI     CTS
        JNZ     TONES
        LXI     D,MES3          ; say  cts is over
        MVI     C,PRMESS
        CALL    CPM
        MVI     A,DECODE+NOTONE ; turn on the decoder and
        OUT     R0              ; keep the encoder quiet
TONES1  IN      R1              ;wait for a tone to come in
        ANI     TDV
        JZ      TONES1
        IN      R0              ; and read it
        ANI     TONE            ; clean it up
        CPI     12              ; if its a # symbol then quit
        JZ      PEND
        MOV     E,A             ; else get ascii representation

        MVI     D,0             ; from the table
        LXI     H,TBL
        DAD     D
        MOV     A,M
        MOV     E,A             ;  and print it
        MVI     C,CONOUT
        CALL    CPM
        JMP     TONES1

PEND    XRA     A               ; hang up
        OUT     R1
        JMP     WMBOOT          ; and quit


WAIT    IN      R0              ; same as routine in TTDIAL.ASM
        ANI     TIMER           ; this routine hangs the number
        JZ      WAIT            ; of 1/10thsof a second thats
WAIT1   IN      R0              ; stored in B
        ANI     TIMER
        JNZ     WAIT1
        DCR     B
        RZ
        JMP     WAIT

TBL     DB      'D1234567890*#ABC'
MES1    DB      CR,LF,LF,'WAITING FOR PHONE TO RING...$'
MES2    DB      CR,LF,LF,'RINGING... GOING OFF HOOK',CR,LF,LF,'$'
MES3    DB      CR,LF,LF,'CLEAR TO SEND RECEIVED',CR,LF,LF
MES31   DB      'TONES ENTERED : $'
WORDS   DB      27,2,35,88,99,53,53,62,62,62        ; "HELLO"
WDS1    DB      130,128,141,141,170,186,62          ; "ENTER"
WDS2    DB      106,114,99,106,80,42,53,55,13,18,63 ;"TOUCHTONES"

        END
```

12.4 OTHER TEST PROGRAMS

12.4.1 DIALTONE.BAS

This routine simply tests the dial tone bit and ring/dial tone bit. It also checks to see if the dial tone bit is stuck on. The program picks up the line and checks immediately for dial tone. If it gets dial tone immediately, it assumes that the bit is stuck. If it doesn't detect dial tone right away, it loops around waiting for it.

```
10 REM THIS ROUTINE WILL TAKE THE PHONE OF HOOK AND LOOK FOR DIAL TONE
20 R0=&HC4 : R1=R0+1 : R2=R0+2 : R3=R0+3
30 B0=1 : B1=2 : B2=4 : B3=8 : B4=16 : B5=32 : B6=64 : B7=128
40 OUT R0,B4 : OUT R1,0                    : REM RESET EVERYTHING
50 OUT R1,B6                               : REM GO OFF HOOK
60 IF (INP(R1) AND B2)=0 THEN 100
70 IF (INP(R1) AND B2)=B2 OR (INP(R0) AND B7)=B7 THEN PRINT
"NOTHING    "; ELSE PRINT "DIAL TONE ";
80 PRINT CHR$(13);
90 GOTO 70
100 PRINT "DIAL TONE BIT STUCK ACTIVE (LOW)"
```

12.4.2 LINECUR.BAS

This program tests the line current by taking the phone off hook and polling the line current bit.

```
10 REM THIS ROUTINE WILL TAKE THE PHONE OF HOOK AND LOOK FOR DIAL TONE
20 R0=&HC4 : R1=R0+1 : R2=R0+2 : R3=R0+3
30 B0=1 : B1=2 : B2=4 : B3=8 : B4=16 : B5=32 : B6=64 : B7=128
40 OUT R0,B4 : OUT R1,0                    : REM RESET EVERYTHING
50 IF (INP(R1) AND B0)=0 THEN
PRINT "LINE CURRENT STUCK ACTIVE (LOW)" : END
60 OUT R1,B6                               : REM GO OFF HOOK
70 FOR R=1 TO 50 : NEXT R
80 IF (INP(R1) AND B0)=0 THEN "LINE CURRENT OK" ELSE PRINT
"LINE CURRENT STUCK OFF (HIGH)"
90 OUT R1,0
```

12.4.3 PHONEMES.BAS

This program steps through all the possible phonemes the votrax can generate. Listen on an extension phone. After calling a suitable number, the program will pick up on the line and start running through the phonemes in sequence. It repeats this sequence until the program is halted.

```
10 REM THIS ROUTINE WILL RUN THRU ALL THE PHONEMES IN THE VOTRAX
15 REM
20 R0=&HC4 : R1=R0+1 : R2=R0+2 : R3=R0+3
30 B0=1 : B1=2 : B2=4 : B3=8 : B4=16 : B5=32 : B6=64 : B7=128
40 OUT R0,B4 : OUT R1,0                    : REM RESET EVERYTHING
50 OUT R1,B6                               : REM GO OFF HOOK
60 OUT R0,B5+B4                            : REM ENABLE VOTRAX
70 FOR X=0 TO 255
80 IF (INP(R0) AND B5)=0 THEN 80           : REM WAIT FOR VOTRAX
85 REM                                          BUFFER EMPTY
90 OUT R2,X
100 NEXT X
110 GOTO 70
```

12.4.4 RINGING.BAS

Similar to the dial tone test software, this routine indicates the presence of ring on the phone line. With the program running, call the number the MM-VT1 is connected to. When the phone rings, the software will print out "RINGING."

```
10 REM THIS ROUTINE LOOKS AT RING
20 R0=&HC4 : R1=R0+1 : R2=R0+2 : R3=R0+3
30 B0=1 : B1=2 : B2=4 : B3=8 : B4=16 : B5=32 : B6=64 : B7=128
40 OUT R0,B4 : OUT R1,0                    : REM RESET EVERYTHING
60 IF (INP(R1) AND B2)=0 THEN 100
70 IF (INP(R0) AND B7)=B7 THEN PRINT " NOTHING    ";
ELSE PRINT " RINGING    ";
80 PRINT CHR$(13);
90 GOTO 60
100 PRINT "DIAL TONE BIT STUCK ACTIVE (LOW)"
```

12.4.5 PLB.BAS

This routine will help in setting and testing the PLB (Phone Line Bit). Manually dial up another line and run this program. It displays, on the fly, the status of the bit. A dash is high and an underscore is low.

```
10 REM                    PHONE LINE BIT TEST & SET SUBROUTINE
20 REM
25 WIDTH 255
30 R0=&HC4 : R1=R0+1 : R2=R0+2 : R3=R0+3
40 B0=1 : B1=2 : B2=4 : B3=8 : B4=16 : B5=32 : B6=64 : B7=128
45 OUT R0,B4
50 OUT R1,B6
60 X=1
220 IF (INP(R1) AND B1)=B1 THEN PRINT "-"; ELSE
PRINT CHR$(95); :REM UNDERSCORE
230 X=X+1
235 IF X<80 THEN 220
240 PRINT CHR$(13);
250 GOTO 60
```

12.4.6 TIMERPULSE

This routine will help in testing the timer pulse output bit. It will count off seconds elapsed which allows the timer to be easily checked.

```
5   R0=&HC4
10 INPUT "CHECK 10 OR 20 PULSES PER SECOND ?";A
20 IF A=20 THEN OUT R0,64+16 ELSE OUT R0,16
30 FOR X=1 TO A
40 IF (INP(R0) AND 64)=0 THEN 40
50 IF (INP(R0) AND 64)=64 THEN 50
55 PRINT
60 NEXT X
70 B=B+1
80 PRINT B;"SECONDS"
90 GOTO 30
```